



FOOD STORAGE WAREHOUSE

Seattle, WA

January 5, 1995



FIRE INVESTIGATIONS

NATIONAL FIRE PROTECTION ASSOCIATION

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ABSTRACT

A fire in a Seattle warehouse on January 5, 1995, resulted in the deaths of four members of the Seattle Fire Department. All four died when the floor between the upper and lower levels of the building collapsed. The fire, which was determined to have been set intentionally, began in the building's lower level directly below the area in which fire crews were conducting interior fire operations.

The building in which the fire occurred was originally constructed in 1909 with a structural support system of heavy timber. Over the years, however, the warehouse had been modified a number of times. One of these modifications was a cripple wall¹ constructed of material estimated to be 2 inches by 4 inches in dimension, that had been installed to support the joists of the floor assembly between the upper and lower levels. Unfortunately, this cripple wall was more susceptible to fire than the building's other structural support mechanisms and when it failed it caused the floor to fail, creating the opening into which the four fire fighters fell.

As a result of NFPA's on-site investigation, which began the day after the collapse, and subsequent interviews, the following were identified as contributing factors in this incident:

- Confusion about the physical layout of the building, as well as the location of crews working in, above, and around the structure in relation to the fire.
- Lack of awareness on the fireground of the location of the fire and the various crews in relation to the fire.
- Insufficient progress reports transmitted over the fireground frequency.
- Lack of awareness of the length of time the building had been on fire and the passage of time after fire department notification.
- Failure to take into account the fact that the building was a known arson target when formulating the fireground strategy.
- Insufficient information to develop a risk/benefit evaluation of fireground operations.

Over the past six years, the Seattle Fire Department has aggressively sought to enhance firefighter safety by instituting a personnel accountability system that has become the model for many other fire departments around the country, by equipping personnel with protective equipment that meets current standards and portable radios that allow them to transmit an automatic, coded distress call to the dispatch center. Despite these precautions, four fire fighters lost their lives. As this incident so tragically illustrates, a great many dangers must still be accounted for during fire fighting operations.

¹A cripple wall is a short section of a wall that is used to support a larger wall.

I. INTRODUCTION

The National Fire Protection Association (NFPA) became aware of this fire the day it occurred and sent Edward Comeau, Chief Fire Investigator in the NFPA Fire Investigations Department, and Chuck Smeby, Senior Fire Service Specialist in the NFPA Public Fire Protection Division, to Seattle to study it. Comeau and Smeby also participated in a follow-up meeting on site in March 1995. This on-site study of the fire and their subsequent analysis were the basis for this report, which is based on the best available data, on the observations they made during data collection, and on additional information provided while the report was being developed. Access to the fire scene and data collection was made possible through the cooperation of the Seattle Fire Department. Because the incident was under criminal investigation, the NFPA was not able to physically document the design of the structure or verify the construction features. The analysis of the building is based on city records, information provided by city officials and an inspection of the debris that was removed from the structure. Information regarding fireground operations and crew activities was obtained during interviews conducted jointly by the Seattle Fire Department, the NFPA, and personnel from the United States Fire Administration.

This study was funded by the NFPA as part of its ongoing program to investigate technically significant incidents. It is not the NFPA's intention that this report pass judgment on, or fix liability for, the loss of life or property resulting from this fire. Rather, the NFPA intends that its report present our findings and highlight the factors that contributed to the loss of life and property. The NFPA's Fire Investigation Department documents and analyzes details of such incidents so that it may report lessons learned for life safety and property loss prevention purposes.

The cooperation and assistance of the Seattle Fire Department is greatly appreciated.

II. BACKGROUND

Seattle Fire Department

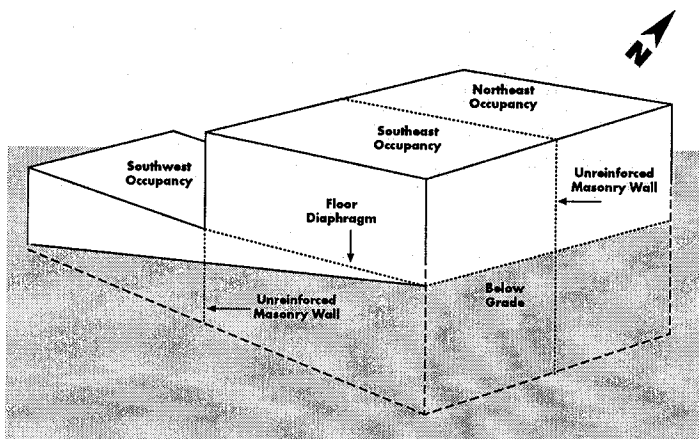
The Seattle Fire Department is a fully paid department consisting of 1,000 uniformed members. There are 62 units located in 33 stations throughout the city. The department serves a population of 522,000 people over an area of 91 square miles.

Firefighter Protective Clothing

At the time of the fire, all of Seattle's fire fighters were equipped with polycarbonate helmets, Nomex™ turnout coats and pants, leather gloves, positive-pressure SCBA at 4500 psi, PASS devices, portable radios, and flashlights. Protective hoods were not part of their standard equipment. According to the Seattle Fire Department, all of the equipment met NFPA standards.

The Building

The warehouse in which the fire occurred was originally built in 1909 and had been modified a number of times over the years. According to plans provided by the City of Seattle Building Department, it had originally been a square structure. At the time of the fire, however, it was an L-shaped building occupied by a frozen food company, a bakery, and an unused warehouse.



² Due to the criminal investigation, which was ongoing at the time of NFPA's site visit, it was not possible to inspect and document the interior of the structure in order to determine specific design features. In addition, much of the structure was damaged during the fire and the subsequent rescue and recovery operations. Much of the information used in documenting the structure was obtained from City of Seattle records and information provided by city officials.

A variety of construction techniques were used throughout the building, which was a combination of unreinforced masonry, heavy timber, and wood-frame covered with either lightweight metal panels, decorative stucco panels, or shiplap. In the area most extensively damaged by the fire, the exterior walls were constructed of unreinforced masonry and the structural frame was made of heavy timber columns supporting heavy timber beams. The connections between the columns and beams were cast iron plates, that rested on top of the columns and supported the horizontal beams. The building had no sprinkler, smoke detection, or fire alarm systems.

The original building was a one-story structure. At some point, however, the street on the east side was raised and a second story was added. Additions were also made to the west and north sides, and what had once been the street level of the building was now its basement.

The floor between the lowest level and the upper level was constructed of 5" x 1-3/4" planking that rested on floor joists that rested, in turn, on timber beams that measure 13" x 8". A layer of concrete about 1/2" thick covered the planking.³ According to statements from the interior crews, they had believed that they were working on a solid concrete floor rather than one with a thin layer of concrete over wood.

When the floor was added, a cripple wall about 4 feet high was built to support where the new floor met the existing fire wall, separating the north and south occupancies. This cripple wall, which was made of wood that appeared to be approximately 2" by 4" in dimension, supported the floor joists that ran north to south. (A similar type of wall in the same area that was recovered and inspected by NFPA was constructed of studs which measured 2-3/4" x 3-1/2" and covered with wood sheathing measuring 5" x 1") Although it provided critical structural support, the cripple wall was not of the same construction as the structure's main support mechanism and did not have the same structural or fire-resistance characteristics as the main structural system.

The upper levels of the building were occupied by the frozen food company and were used in food preparation. The lower, northeast level was used as storage and was also rented out to a rock band as a practice area. The lower, southeast level was a storage area. There were no openings or stairwells between the upper and lower floors of the southeast occupancy. The one-story southwest area was divided into a bakery and a loading dock. Due to the extensive fire damage the exact interior configuration could not be determined, but the occupants reported that there were also a number of rooms and offices.

From the outside, each face of the building presented a significantly different image. From the west side, it looked like a two-story structure constructed of various materials. When viewed from the north, a steep grade partially obscured the details of the building and the structure appeared to have two stories, although only one level was accessible from the east side. From the east, it appeared to be a one-story building with no lower level. And from the south, heavy vegetation obscured the building so that only one floor was visible until one approached the parking lot at the southwest corner.

The layout of the building, the adjacent structures, and the sloping grades made it impossible to drive around the structure to size it up. However, it was possible, with some difficulty, to walk around the building.

Fire Protection Systems

The building was not equipped with any sprinkler systems, smoke detection systems, or fire alarm systems.

Means of Egress

Due to the extensive fire damage to the structure, it was not possible to determine the interior configuration of the structure and the egress capacity. No plans could be located that indicated the interior layout.

³ This analysis was based on an inspection by NFPA investigators of the debris removed from the structure

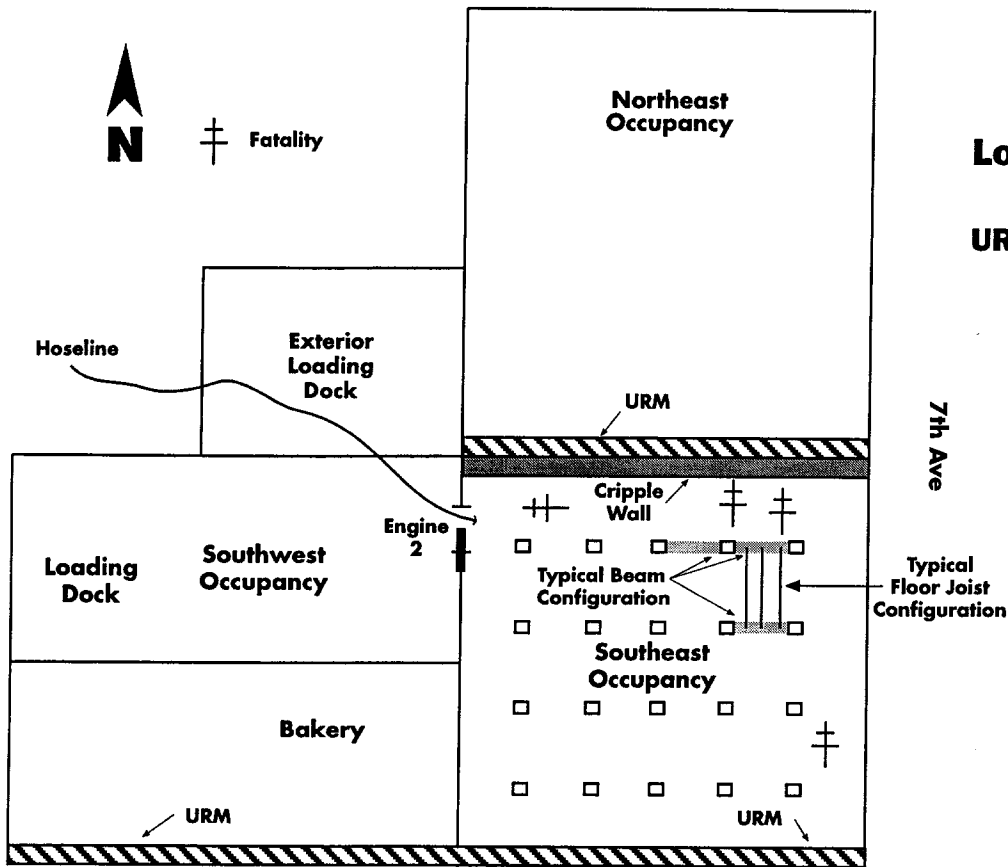


⊕ Fatality

Northeast
Occupancy

Lower Level

URM= Unreinforced Masonry

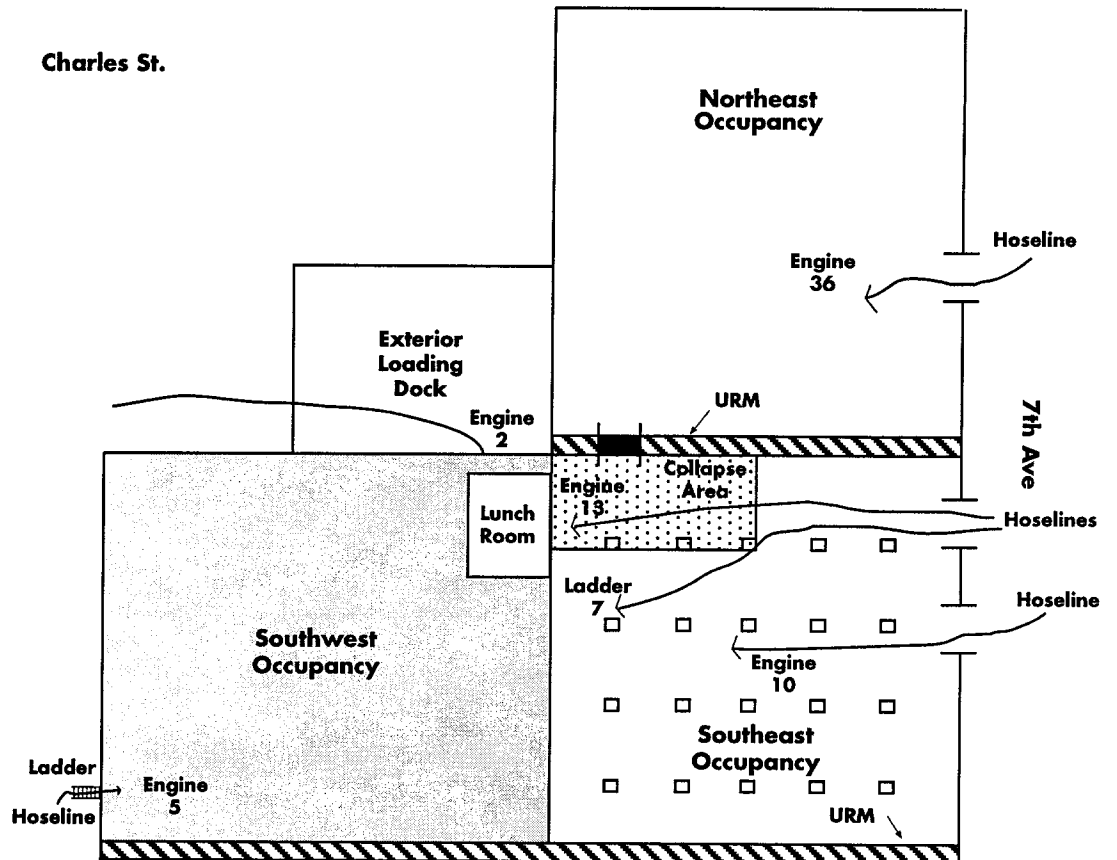


COMMAND
POST

Charles St.

Northeast
Occupancy

Upper Level



COMMAND
POST

Charles St.

THE FIRE

East Operations

On January 5, 1995, the temperature was 37°F, there were scattered high clouds, and the winds were out of the southeast at 9 miles per hour.

The fire was discovered by the members of a rock band who were practicing in the lower level of the north occupancy. They called the Seattle Fire Department at 7:02 p.m. As soon as it received the alarm, the fire department dispatched a first-alarm assignment that included Engines 10, 5, 2, 13, and 36; Ladders 1 and 3; Battalions 1 and 5; Aid 5; Medic 1; and Air 9. The occupants took no action to suppress or control the fire.

The first-arriving unit, Engine 10, responded south on Maynard, then east on Charles, and stopped at the hydrant at the corner of 7th Avenue and Charles Street at approximately 7:07 p.m. (5 minutes elapsed time).⁴ The officer on Engine 10 initially reported a well-involved building fire, noted that his crew was laying a manifold for a 1-1/2" line, and said that Engine 10 would be command.⁵ In interviews conducted jointly by the Seattle Fire Department and NFPA, the crew stated that they could see that the fire, which they thought to be an exterior fire, had spread to the building.

At 7:08 p.m. (6 minutes elapsed time), Battalion 1 arrived and established a command post at the building's rear driveway on the west side. Battalion 1 met with the officer from Engine 10 to discuss the plan for an interior attack from the east, which was approved. He then assumed command and gave an initial report of a two-story structure, measuring approximately 50 feet by 80 feet. According to his initial strategy, Engine 5 would operate on the exterior from the west side and Engine 10 would attack from the interior on the east side.

Engine 13 soon arrived, followed by Battalion 5. The crew of Engine 10 had deployed a manifold and ad-

vanced a 1-3/4" attack line to the building from the east side. Engine 13 also advanced an attack line to this door, alongside of Engine 10. Fire fighters forced open a door on the east side into the southeast occupancy, and personnel from Engines 10 and 13 entered the building under the direction of the officer from Engine 13. The officer from Engine 10 assumed the position of the east division on the exterior of the building.

Battalion 5 was in quarters at Station 13 and followed Engine 13 to the fire. Battalion 5 reported to Battalion 1 and was told to assume Division B on the east side from Engine 10 at 7:13 p.m. (11 minutes elapsed time). At this time, Engine 13 was in the building, Ladder 1 was on the roof, and two members of Engine 10 were inside the building. The officer from Engine 10 told Battalion 5 which of his personnel were inside of the building and passed on his accountability clipboard. He then entered the building with another fire fighter, advancing a third hose line into the structure.

When Ladder 1 arrived on the scene, they parked on the east side of the structure. Its crew, advancing to the roof to begin ventilation operations, noted that the fire was lapping up over the west edge of the roof of the southeast occupancy. When crew members tried to ventilate the building near this edge, the fire forced them back. They requested that a hose line be brought to the roof for protection, then began to make a trench cut from north to south to stop fire spread to the east. The construction of the roof with several layers of roofing material and a small cockloft made this difficult.

Crews inside the structure reported that smoke was heavy, visibility was poor, and that they noticed a number of spot fires as they advanced a 1 3/4-inch line through the door. According to reports from Engine 13's crew, who entered the building from the east side, crew members were only able to advance about 10 feet before the heat forced them down on the floor. One fire fighter reported that he moved into the building by keeping his right hand on a wall, and that there was fire to his left. Another reported that he felt so much heat coming up through the floor that he could not keep his knees on the floor.

⁴All of the elapsed times are based on the time of alarm, which was 7:02 p.m.

⁵The Standard Operating Procedures for the Seattle Fire Department is to do a reverse lay (from the fire to the hydrant) and deploy a manifold, which is supplied by a 4-inch supply line off of the pumper. The manifold has six 2-1/2-inch discharges. If a 1-1/2-inch line is to be used, a 2-1/2-inch to 1-1/2-inch gated wye will be attached to one of the manifold discharges and then advanced forward.

Fire fighters from Engines 10 and 13 were able to advance all the way to the west wall, where they found a large body of fire in the lunch room located on the west side of the southeast occupancy. They were beginning to make progress suppressing it when their low air alarms started to sound, and they backed out of the building. However, before they did so, members of Engine 13's crew reported that they heard a hose stream hitting the outside wall from the west. At 7:23 p.m. (21 minutes elapsed time), Division B reported that Engine 13 was coming out to change bottles.

Engine 36 was assigned to enter the northeast occupancy from the east, and its crew advanced a line into this area. Crew members found only minor fire extension, which they extinguished.

The officer from Ladder 7, which had arrived on the scene at 7:16 p.m. (14 minutes elapsed time), went to the command post and was assigned to Division B on the east side. While going over to the east side, he encountered the officer from Engine 10 who was outside the structure changing his air bottle.

Ladder 7 was originally ordered to advance a line to the roof of the building. While his crew was pulling a line, the officer climbed the ladder to the roof and met with the officer from Ladder 3. Before his crew could advance the line up the ladder, however, their assignment was changed by Division B, and they were ordered instead to help with the interior attack. They had just begun advancing a line in the door when they met another crew backing out. They picked up the departing crew's line and continued into the building. By this time, personnel from Ladder 7 reported that smoke inside the building was extremely heavy, although it was cool enough to stand up.

While he was changing his bottle outside the building, the lieutenant from Engine 13 asked Command to shut down the hose stream operating on the exterior west side to keep opposing hose streams from operating on the crews inside the building. After he did this, he re-joined his crew on the east side. The officers from Engines 10 and 13 discussed the situation briefly, then reentered the building from the east side with their crews. They did not update Division B on conditions in the building.

At about this time, someone told Division B (Battalion 5) that the building was the Pang Building and that it had been under an arson watch. Battalion 5 passed this information on to someone from fire investigations.

At 7:27 p.m. (25 minutes elapsed time), Command realized that the original division designations were incorrect. As a result, Division B, which was located on the east side of the building and assigned to Battalion 5, was changed to Division C, and the officer from Battalion 2 on the west side of the building was designated Division B.

The Assistant Chief of Operations and the Safety Officer, who had both arrived on the scene by this time, talked to Division C (Battalion 5) before climbing on the roof to assess its condition. The Safety Officer asked whether a rapid intervention team had been established, and Division C reported that it had. Both officers asked Division C if the building had a basement, and he replied, based on his belief that the building was a one-story structure, that it did not.

Ladder 1, operating on the roof, was joined by Ladder 3, and the two crews began to make a trench cut in the roof. When the officer on Ladder 3 tried to tell Division C that the smoke coming from the opening was "lazy smoke" and not smoke under pressure, he found that he was unable to reach him by radio. He decided to tell the command officer directly and climbed down the ladder.

By this time, the Assistant Chief of Operations and the Safety Officer were on the roof assessing conditions. At 7:36 p.m. (34 minutes elapsed time), the Assistant Chief advised command that a command officer was needed on the roof and the officer from Ladder 3 was directed to assume that position until a command officer could be assigned. The officer from Ladder 3 began climbing back up the ladder to the roof.

By this time, heat and smoke conditions had improved significantly within the structure and personnel were finally able to stand up. Since there was no significant fire involvement, two fire fighters from Engine 13 went back to the line they had left in place when they originally backed out of the building and returned to the lunch room on the west side to continue fighting the fire. By now the fire had burned holes in the exterior

walls and the fire fighters began enlarging them to create an escape path through the exterior wall of the lunch room onto the roof of the southwest occupancy in the event that they needed to evacuate the structure in an emergency.

About this time another fire fighter from Engine 13 said to the two men in the lunch room, "Let's go." He then repeated himself and 10 or 15 seconds later the floor in the main part of the structure collapsed. The two fire fighters in the lunch room managed to climb through the holes they had just enlarged onto the roof of the building next door. Looking back, they saw that the entire west wall of the building was now fully involved.

At the same time the crew from Ladder 7, which was operating a hose line inside the building, reported that they could hear saws running overhead. When they stopped advancing so that they would not be working under the saws, the officer from Engine 10 stopped to talk to them briefly before moving away. Very shortly thereafter, they heard a rumbling and the whole area became very hot. The officer used the hose line to spray water overhead, where it turned to steam and burned him. He then turned the hose on the crew to protect them while they evacuated the building. The crew became disoriented at one point and came within about a foot of the hole in the floor before they reoriented themselves and left the building through the door on the east side through which they had entered.

At 7:38 p.m. (36 minutes elapsed time) Division C gave the order to abandon the building.

The two members of Engine 13 who had left the building through the opening in the wall climbed down a ladder from the roof of the adjacent building and reported to a command officer on the west side that people were trapped inside. They then went around to the east side of the building and reported to the officer in charge of Division C that at least two fire fighters were still inside. The officer checked his accountability passports and confirmed their report.

West Operations

Dispatched on the original assignment, Engine 2 was ordered to the west side of the building and when it ar-

rived its officer was told to assume command of Division C, with Engine 5 reporting to him. The incident commander told him that the strategy was to attack the fire from the east, or unburned, side and push it west. His crew was to protect the exposures and stop the fire from spreading north.

Engine 2 laddered the one-story southwest occupancy and Engine 5 advanced a hose line to its roof. The remainder of the crew from Engine 2 then went to the loading dock located at the juncture of the building's three sections, knocked out some siding, and entered the loading dock in the southwest occupancy where they found several vehicles and some minor fire extension at the ceiling. They used a step ladder standing inside the building where they had made their opening to advance a hose line into the interior loading dock, then moved to a door that led into the southeast occupancy. The door was open approximately 1 1/2 feet and they were unable to open it any further. At this point, they noticed a large volume of fire, which they described as "free burning," on the other side of the door on the lower level.

The crew from Engine 5 advanced a hose line to the roof of the southwest occupancy and began applying water through the windows from the ladder. When they realized that there were opposing interior hose streams, however, they stopped. One of the fire fighters thought that the fire looked as though it was coming from underneath the floor on which the crews were working, but he did not say anything about it to anyone. The crew from Engine 5 then climbed back down the ladder, and crew members were ordered to open the doors on the southwest occupancy that led into the bakery. When they got the doors open, they did not see any smoke or fire in the area, although they did not go inside.

At 7:29 p.m. (27 minutes elapsed time), Battalion 2 was assigned as Division C on the west side.

Staff (Command) Officers

The officer from Battalion 1 was the incident commander for this fire and responded from Station 1. When he arrived on the scene, he met with the officer from Engine 10, and they reviewed the plan Engine 10 had established when it arrived. The officer from Battalion 1 agreed with the plan, and at 7:08 p.m. (6 min-

utes elapsed time), he assumed command and reported that fire fighters were working at a two-story, 50-foot by-80-foot building. He noted that Engine 10 would attack the fire from the interior on the opposite side, while Engine 5 would operate on the exterior from the rear. He established his command post in the driveway on the southwest corner of the building on Charles Street.

The Deputy Chief of Training and Safety was off duty at the time of the fire and responded from his home at 7:18 p.m. to assume the position of safety Officer. He met briefly with the officer in charge of Division B on the east side, then walked about 10 feet into the upper level of the southeast occupancy to evaluate conditions. At that time, he noticed that the smoke was light and that there was no active fire. He then went south on 7th Street and west on Charles Street until he met the incident commander at the command post, where they conferred about the conditions and the fire operations plan. When they were done, the safety officer then walked along the west side until he reached the west door, that led to the bakery. From the doorway, he saw very light smoke in the area and no fire. He did not enter the bakery.

The Safety Officer then retraced his steps to the east side where he met the Assistant Chief of Operations, and the two of them climbed to the roof to assess conditions and operations up there. Around this time, he noticed heavier smoke and embers coming from the overhead door on the east side of the building.

The Assistant Chief of Operations was also off duty when the alarm sounded and arrived at the scene at 7:31 p.m. (29 minutes elapsed time). As he approached the building from the east, he noted a large thermal column coming from the building. When he looked inside the structure from the east side, however, he realized that it was not extremely hot and that the smoke was curling back into the building. This led him to believe that the fire was not in the area in which the crews were operating and that there might be a concealed fire. He asked Division B whether the building had a basement and was told that it did not. This led him to believe that there might be a cockloft fire.

He then walked over to the command post and met with the incident commander to review the plan of attack. The Assistant Chief suggested that a third alarm be dis-

patched and left to continue his assessment in anticipation of assuming command of the incident. A third alarm was dispatched at 7:32 p.m. (30 minutes elapsed time).

The Assistant Chief and the Safety Officer returned to the east side of the building and climbed to the roof to assess conditions there. The Assistant Chief radioed the incident commander to request that a command officer be assigned to roof operations because he felt, based on smoke conditions, that the main body of fire had still not been vented. Very shortly after this, the floor collapsed.

Rescue Operations

When the floor collapsed, 13 fire fighters from three crews were working inside the building over the fire area and nine fire fighters from two ladder crews were working on the roof.

Using the personnel accountability system, the incident commander quickly determined how many fire fighters were trapped and where they were trapped, and immediately ordered aggressive actions to rescue them. Unfortunately, the rescuers were unable to reach the victims despite several aggressive attempts.

The trapped fire fighters were all equipped with radios, and at least one of them was able to activate his "emergency traffic" signal. This transmits a coded signal to the fire department dispatch center, where a display indicates the name of the firefighter who has activated his radio. The dispatch center relayed the information to the incident commander, but the trapped man was unable to communicate his location or condition.

According to information provided by the Seattle Fire Department, all four members appeared to have all of their personal protective clothing and equipment in place, which included helmets, SCBA's, bunker pants and coat, gloves, boots, PASS units, flashlights and portable radios. During the subsequent investigation, it was determined that two of the PASS units were in the "OFF" position (unit would not operate), one was in the "ON" position (the user had manually activated the unit), and one was in the "AUTO" position (the unit would automatically activate in this position).

Casualties

Four fire fighters died during this operation. All four had been operating over the fire and were caught in the collapse of the floor between the lower and upper levels. Their bodies were found on the lower floor. According to the Seattle Fire Department, three of the fire fighters died from asphyxiation due to depletion of air in their SCBA's, while one was asphyxiated due to exposure to products of combustion.

Structural Damage

In its subsequent analysis of the incident, the Seattle Fire Department determined that the building had been significantly modified in the area where the collapse occurred. The structural elements of the southeast occupancy were predominantly large timbers that supported the floor joists. Where the joists butted up against the brick wall separating the southeast and northeast occupancies, however, a cripple wall made of 2 inch x 4 inch studs had been constructed. This wall rested on a ledge in the brick wall. When the fire burned through the smaller elements of the cripple wall, the floor it supported collapsed causing the four fire fighters to fall into the area below.

Cause and Origin

The fire was determined to have been arson and the probable point of origin was the lower level of the southeast occupancy. There was also fire in the lower level of the northeast occupancy. The fire spread to the upper story along the exterior of the building and through interior penetrations.

Before the fire, the building had been identified by the department's arson investigators as a potential target for arson. The building was under surveillance for a period of time, but the watch had been terminated approximately two weeks before the fire broke out. The companies assigned to the first alarm had been told that the building was under an arson watch.

DISCUSSION

The building in which this fire occurred was 86 years old and appears to have been of heavy timber construction, although it had been significantly modified over the years. These modifications, coupled with the confusion about the number of stories it contained and the actual location of the fire, influenced the outcome of the incident.

Several other factors also contributed to this incident:

• Incident Command and Fireground Operations

The first-arriving unit established incident command and several layers of command officers developed and reviewed its strategy. An organizational structure was established with effective spans of control, as stated in NFPA 1500, Standard on Fire Department Occupational Safety and Health Program:

6-1.5 At an emergency incident, the incident commander shall have the responsibility to:

- (a) Assume and confirm command and take an effective command position;
- (b) Perform situation evaluation that includes risk assessment;
- (c) Initiate, maintain, and control incident communications;
- (d) Develop an overall strategy and attack plan and assign units to operations;
- (e) Develop an effective incident organization by managing resources, maintaining an effective span of control, and maintaining direct supervision over the entire incident by creating geographic and functional sectors.

Each company on the fireground was operating under the incident command system, with the exception of two ladder companies on the roof over the southeast occupancy. According to information provided to NFPA, the incident commander was unaware of the roof top operations, which does not comply with Section (e)

above and, as a result was not able to develop an effective strategy based on the actions taking place on the fireground.

The Seattle Fire Department indicated that by Standard Operating Procedures they commit the first two engine companies and the first ladder company and that they have pre-established operating procedures.

• Resources

At the time of the collapse, there were approximately 52 fire fighters on the scene from 14 crews. Eight command officers, including a safety officer, were also on the scene. An additional eight units—six engines, one ladder, and one command van—and a command officer had been dispatched before the collapse, but some of these units were just arriving on the scene when the floor collapsed. It would appear that the resources on the scene were adequate for fire fighting operations. This is in compliance with the 1992 edition of NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, which states:

6-4.1 The fire department shall provide an adequate number of personnel to safely conduct emergency scene operations.

• Size-Up

The first-arriving crew apparently thought it was fighting a fire that had started on the exterior of a one-story building and spread to the interior, despite the fact that one crew member reported in subsequent interviews that the floor was so hot he could not kneel on it. The incident commander stated in his initial size up report that he was aware that the building was a two-story structure. However, he was unable to identify the hazards his crews might encounter, given his perspective and the lack of adequate progress reports. Nor would his limited view of the building allow him to formulate a complete picture of the structure or the location of the crews operating in, around, and above it.

A complete size-up of the building was not completed before the collapse. The safety officer and a command officer (who would subsequently assume command) were both in the process of walking around the build-

ing and had discovered that it was a multi-grade structure when the floor collapsed, but they had not had an opportunity to communicate this to the incident commander.

• Communication/Progress Reports

It appears that the crews involved in the fire fighting operations did not make sufficient progress reports. The interior crews did not provide ongoing reports to either their sector officer or to command, even though they felt they were making headway on the fire. When the members of Engine 10's crew pulled out to replace their SCBA bottles, the officer from engine 13 reportedly met with the incident commander to discuss applying an exterior hose line on the fire area. Since this discussion did not take place on a radio, other personnel on the scene were unaware of it.

In subsequent interviews, the interior crews reported that there were heavy fire conditions in the interior of the upper level of the southeast occupancy, but that they managed to knock them down and begin hitting spot fires. After they refilled their SCBA's and re-entered the building from the east, they reported that conditions had improved dramatically inside of the building. However, a crew outside the structure on the west side, on the lower level, noted a large working fire inside this structure as the members stood in a doorway. Because they thought the interior crews were going to attack the fire from the opposite direction using an interior stairwell, they did not try to fight the fire because they did not want opposing hose streams.

If the incident commander had realized that one crew was faced with a large fire, while another was attacking spot fires, he might have realized that the crews were on two different levels. Furthermore, others on the fireground might have recognized the conflicting information and reacted to it if the progress reports had been made over the radio.

In addition, an officer on the roof reported that smoke coming out of a ventilation hole early in the incident was "lazy smoke" and not under pressure. This was not consistent with a large fire located directly underneath the roof, but with a fire located somewhere else in the structure.

• Risk Analysis

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, states:

6-2.1.1 The concept of risk management shall be utilized on the basis of the following principles:

(a) Activities that present a significant risk to the safety of members shall be limited to situations where there is a potential to save endangered lives.

(b) Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of members, and actions shall be taken to reduce or avoid these risks.

(c) No risk to the safety of members shall be acceptable when there is no possibility to save lives or property.

6-2.1.2 The Incident Commander shall evaluate the risk to members with respect to the purpose and potential results of their actions in each situation. In situations where the risk to the fire department members is excessive, as defined by 6-2.1.1 of this section, activities shall be limited to defensive operations.

Furthermore, NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, states that the incident commander shall be responsible for reviewing, evaluating, and revising the attack plan as required.

In any fire fighting operation, the incident commander should constantly reevaluate the effectiveness of the strategy and modify the tactics accordingly. If no significant progress is made on a fire where crews are working inside a structure, the incident commander should consider changing tactics since the ongoing fire is structurally weakening the building. In this instance, the collapse occurred 36 minutes into the incident, during which time the building had been exposed to a severe fire.

In addition, the building had been under an arson watch and this information had been given to the first-due

crews several weeks before the fire (Prior to this fire, the department had removed the arson watch based on information that the threat was not valid). One of the division command officers on the scene was also told about the arson watch, and he, in turn, relayed the information to a fire department investigator who arrived at the site. It is not known whether the incident commander knew about the arson watch. Be this as it may, the building was known to be a potential target for arsonists, and the incident commander could have reevaluated his strategy based on this information to determine whether his crews were being unduly exposed to excessive risks.

• Interior Operations

The crews working inside the structure stayed intact and were in constant communication with the other crews and with their officers who were monitoring the crews' condition. Personnel inside the structure had identified emergency escape routes and two fire fighters actually used such a route when the floor collapsed.

• Personnel Accountability

Personnel accountability systems were in place and being used, as required by NFPA 1500, Standard on Fire Department Occupational Safety and Health Program. In addition, fire fighters were operating in teams of at least two, and all personnel were communicating with each other, either in person or over the radio, also as required by NFPA 1500:

6-4.3 Members operating in hazardous areas at emergency incidents shall operate in teams of two or more. Team members operating in hazardous areas shall be in communication with each other through visual, audible, physical, safety guide rope, or electronic means, or by other means in order to coordinate their activities. Team members shall be in close proximity to each other to provide assistance in case of emergency.

When the collapse occurred, Battalion 5 was able to identify the personnel trapped inside the structure immediately.

• **Structural Design**

This building appeared to be of heavy timber construction. Normally this type of construction will last longer than a structure of lighter wood-frame construction. However, the structural support had been renovated at some point, creating a “fatal flaw” that led to the collapse. It would be reasonable to assume that a building of this age would have had a number of owners who might renovate it. However, it would probably have been difficult to identify this flaw without a detailed inspection of the building by knowledgeable personnel.

• **Layout**

Probably the most significant factor contributing to this fatal incident was the fact that the building had two levels. Members of the crew that attacked the fire from the east thought that they were working in a one-story structure without a basement. Members of the crew working on the west side of the building knew that the building had two floors but thought that the interior crew was fighting with the same body of fire they were confronting.

This confusion over the number of levels and the level where the main body of the fire was located allowed the crews working on the fire to operate longer than they possibly should have. They thought that they were making headway on the fire and were hitting spot fires, while the main body of the fire was actually working below them.

SUMMARY

There were several key factors which influenced the outcome of this incident:

- During the initial size-up, the structure was identified as a two-story building. However, this information was not adequately transmitted to all crews and personnel on the fireground, and some crews were unaware that they were operating over a basement. This also

led to some confusion regarding the location of the fire versus crews performing fire fighting operations.

- Crews and sector officers were not providing sufficient ongoing progress reports. Progress reports would have provided the incident commander with the information required to realize that the conditions being faced by crews in one area (over the fire), who felt that they were making progress and that conditions were improving, were not consistent with fire control or the conditions being observed by other crews on the west side, lower level of the structure who could observe a large, uncontained fire.
- An evaluation of the operations based on the amount of time that had elapsed had not been adequately performed. Any structure that has been under fire attack for 36 minutes is at risk for structural failure, endangering personnel in and above the structure.
- The information that this was a known arson target was not taken into account in formulating the fireground strategy.
- Most of the crews, with two exceptions, were operating under the control of the Incident Command System. An initial strategy was developed and communicated to the incident commander and to other personnel operating on the fireground. Sectors were established, and crews were assigned to those sectors.
- Accountability was in place, which allowed for a rapid determination of who was trapped within the structure.
- Crew integrity was maintained during the fireground operations.

Key Indicators

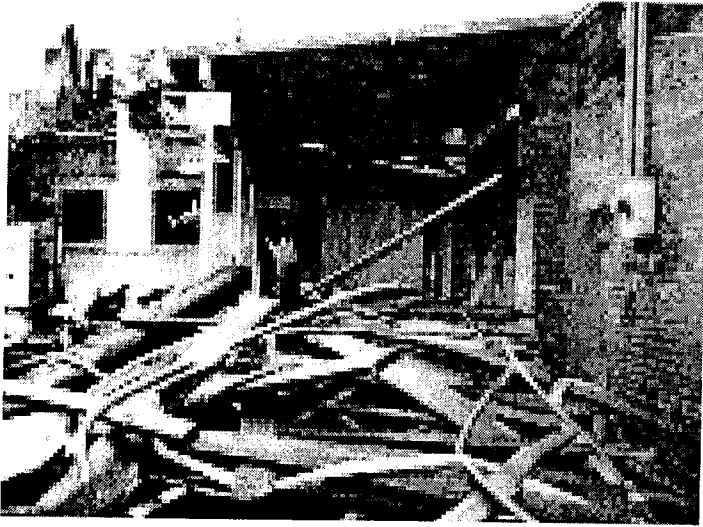
The collapse occurred approximately 36 minutes after the alarm was received. Crews working over the fire had made entry, conducted fire fighting operations, re-filled their air bottles and reentered the occupancy over the fire. During this time they had seen conditions with-

in the upper occupancy improve. However, they had not succeeded in reaching the seat of the fire, nor was any direct fire attack being made on the seat of the fire despite the fact that other crews had made entry into that area on the lower occupancy. There were some key indicators that could have helped provide some information regarding the hazards to be faced within this structure:

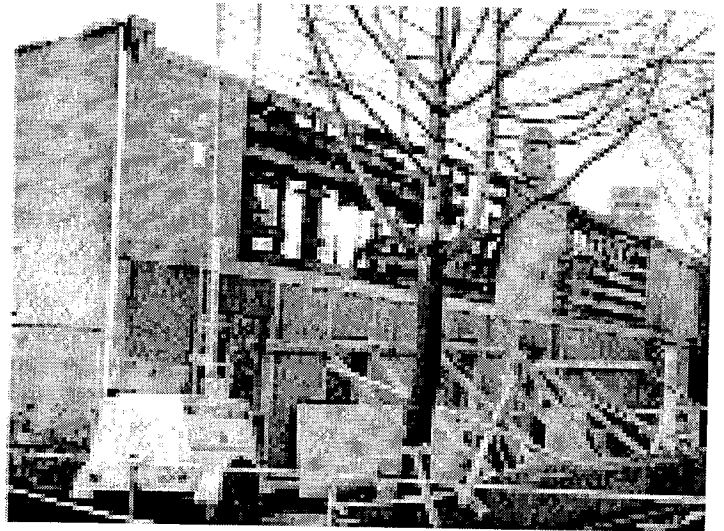
- Multi-grade occupancy.
- Conflicting progress reports from different sectors and crews.
- Inability to achieve fire control within an adequate period of time.
- Lack of awareness that a substantial amount of time had passed from time of alarm.
- Report that this building was a potential target for arson.
- Conflicting observations on fire and smoke conditions.

CONCLUSION

The Seattle warehouse fire is another in a series of recent fires that have resulted in fire fighter fatalities in multi-grade occupancies. Fire fighters and command officers must fully appreciate the hazards presented by conflicting perceptions of the layout of such buildings. Proper training, complete size-up, effective communications, and the use of the incident command system are critical if we are to keep tragedies such as these from reoccurring.



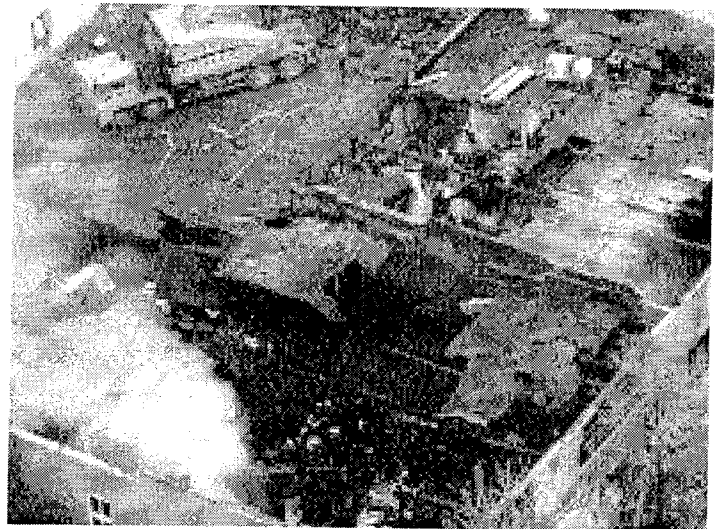
Photograph of the exterior loading dock through which Engine 2 forced entry into the building. Photograph by NFPA.



View of the east side of the building as taken from the corner where Engine 10 was staged. Photograph by NFPA.



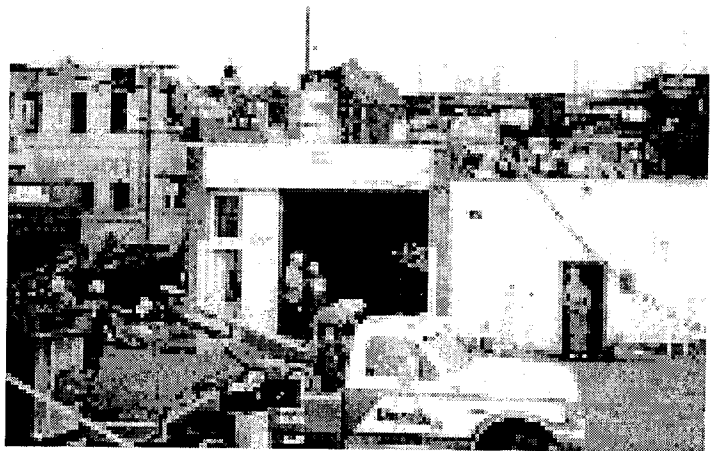
Aerial view (taken from the northwest) of the two story, southeast occupancy in which the collapse occurred. Photo provided by the Seattle Fire Department.



Aerial view (taken from the southeast) of the two story, southeast occupancy in which the collapse occurred. Photo provided by the Seattle Fire Department.



Photograph of the two story, southeast occupancy where the collapse occurred. taken from Charles Street, facing towards the northwest. The sliding fire door seen in the center of the photograph is the door through which Engine 2 observed a large, free-burning fire on the ground floor. Photograph by NFPA.



Ground level photograph of the southwest, one story occupancy which housed a bakery and an interior loading dock. Photo by NFPA.